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UTILISING REAL-TIME SHIP DATA TO REDUCE FUEL CONSUMPTION AND CARBON EMISSION

Ibna Zaman[1][3], Kayvan Pazouki[1], Rose Norman[1], Shervin Younessi[3], Shirley Coleman[2]

[1]School of Marine Science and Technology, Newcastle University, Newcastle upon Tyne NE1 7RU, United Kingdom
[2]Industrial Statistics Research Unit, Newcastle University, Newcastle upon Tyne NE1 7RU, United Kingdom
[3]Royston Ltd, Unit-3 Walker Riverside, Newcastle upon Tyne NE6 3PF, United Kingdom

Abstract

Maritime shipping is estimated to represent around 3% of greenhouse gas (GHG) emission worldwide. Therefore, maritime regulatory bodies have incentivised shipping to operate more efficiently, in order to reduce the CO_2 budget. In response, the industry is trying to become more environmentally friendly by adopting several ways to reduce emissions such as implementing new technologies and operational optimisation. Operators aim to reduce fuel consumption, and as a consequence the ship emissions, in order to gain a competitive advantage. Ship speed is linked with fuel consumption and hence maintaining the optimum speed of the ship would have a significant impact on fuel consumption. The vessel optimum speed can be identified through analysis of real-time ship data operating over different operational profiles. An algorithm has been developed from statistical analysis of sensor data with information from different sensors being correlated and synchronised. The developed algorithm also provides information on estimated fuel consumption, carbon emission and duration for any upcoming journey. The paper demonstrates how ship data has been used to identify optimum speed leading to reduced fuel consumption and emissions.

Introduction

Speed optimisation for a given journey will result in fuel savings. Knowledge of theoretical optimum speed can assist the operator, where and when weather condition permits, to avoid unnecessary fuel consumption during the voyage. In this paper, a methodology is used to identify the optimum speed of a vessel in calm to moderate weather conditions, designated as ECO Speed. In this methodology, statistical models based on the measured operational data (e.g. fuel consumption and speed) of the vessel in calm weather conditions, are used to determine optimum speed for the voyage. The adopted methodology can be used to determine the optimum speed of different ship types and extended to apply to different weather conditions.

Data collection and analysis

Different data analysis methods could be applied to data collected from on board monitoring systems. Trodden et. al. [1] developed their own methods to sequentially filter streamed data to determine steady state operation of a tug boat. Other studies have explored the use of multiple linear regression to develop prediction and control models for the ship fuel consumption [2, 3]. In this study, the real-time ship data (fuel consumption, speed and distance) were analysed to determine the ECO Speed. An on-board fuel monitoring system (engine*i*) has been installed on a case study Offshore Supply Vessel (OSV) to provide fuel consumption, speed and distance data on a per minute basis. This data was collected during a sea-trial, on a real time basis. Additional data was collected manually from the bridge such as the percentage of propeller pitch and engine speed.

The sea-trial of the case study OSV was conducted specifically for the development of the ECO Speed algorithm. The sea-trial was based on a series of runs at different speeds along a measured straight course during which the required measurements were taken over a defined period of time. Figure 1 shows the sea trial course.

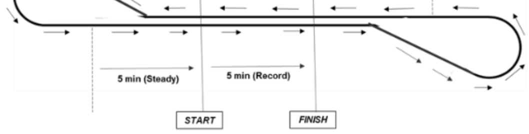

Figure 1: The sea-trial course

The defined time period for the measurements was specific to the candidate ship and this may vary for different vessels with different characteristics. During the sea-trial, the vessel operated according to the following conditions while remaining on the course shown in Figure 1.

- Constant engine speed
- Constant heading

The distance of the measured course for a sea-trial must cover a minimum of one nautical mile [4]. To avoid large deviations in speed while changing the direction of travel, the vessel should turn at each end of the run using a rudder angle of not more than 10 degrees [4]. The vessel operated at different engine speeds over the defined course and the data was recorded when the vessel had reached a steady-state condition.

After collecting all of the data during the sea-trial, different statistical methods were used for the analysis. Fuel consumption for each run at different ship speeds during trial was analysed using regression analysis. The regression model was then used to predict fuel consumption for ship speeds than those used for the trial. Figure 2 shows the fuel consumption rate analysis against speed graph. The regression model, as shown in Figure 2, with R Squared value of 99.7% fits well with the measured data.

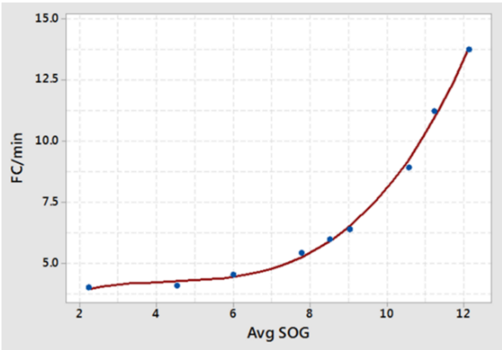

Figure 2: The analysis of fuel consumption rate vs average speed

The regression model was used in a defined voyage scenario of 20 nautical miles. In this scenario, the vessel was assumed to operate at different speeds and the respective fuel consumption for each speed was calculated using the regression model.

Results

The output results from the voyage scenario were plotted to generate a specific speed curve. Figure 3 shows the estimated fuel consumption of the case study vessel travelling for 20 nautical miles at different speeds. The curve in Figure 3 clearly shows the economic speed of the vessel, which is 7.5 knots.

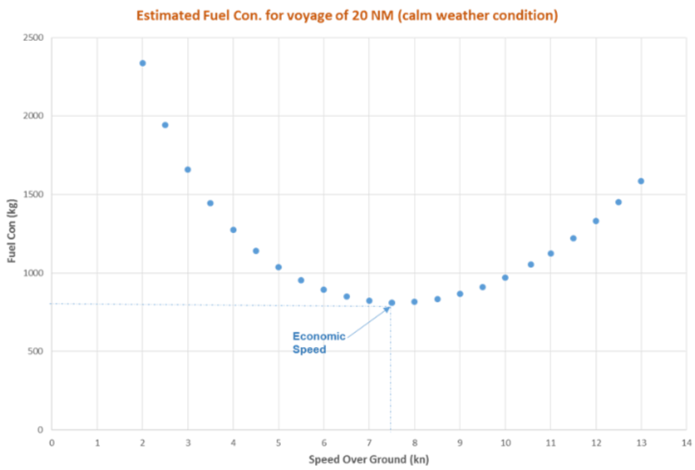

Figure 3: The estimated fuel consumption for different speeds

Further development has been carried out to provide additional information in the ECO Speed system such as difference in time of arrival, percentage of additional fuel used if the vessel speed differs from ECO speed and CO_2 emissions.

Conclusion

This paper describes a methodology for identifying the economic speed of a vessel in operation. The method adopted consists of collecting operational data and carrying out further statistical analysis; it can be applied to any ship type. The results from this study show the potential fuel saving that the case study vessel can obtain, if travelling at ECO speed.

Reference

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